

LESSON 6 AUGER RIGS & EQUIPMENT

DRILLED SHAFT FOUNDATION INSPECTION

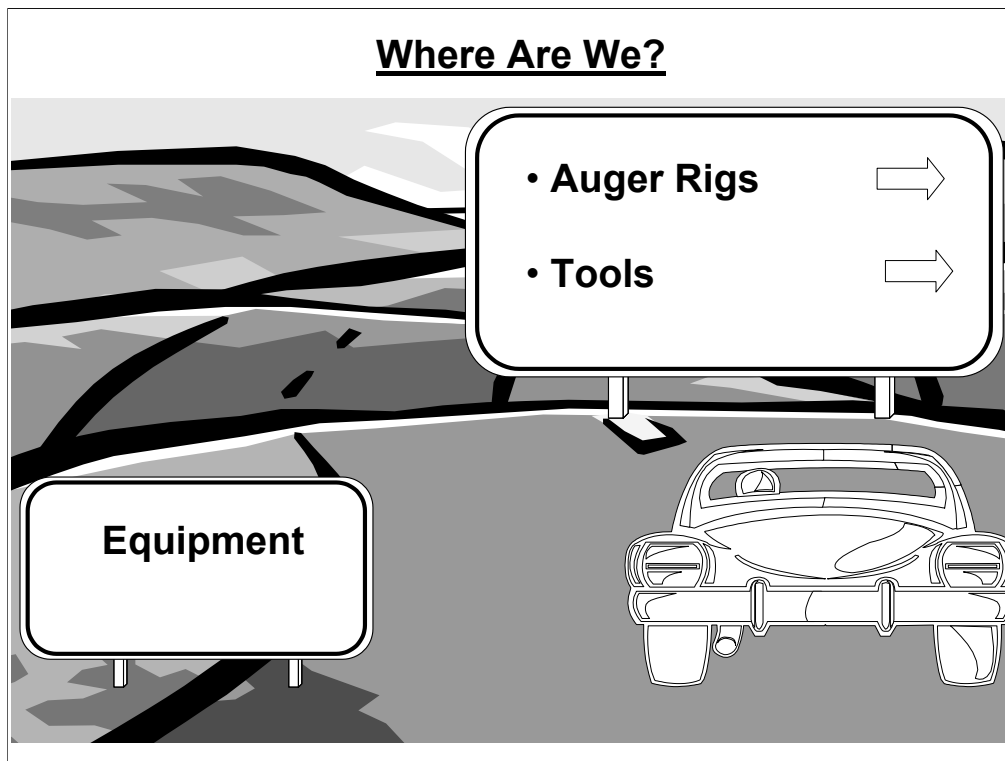
DECEMBER 2002

Participant Workbook

LESSON 6

AUGER RIGS & EQUIPMENT

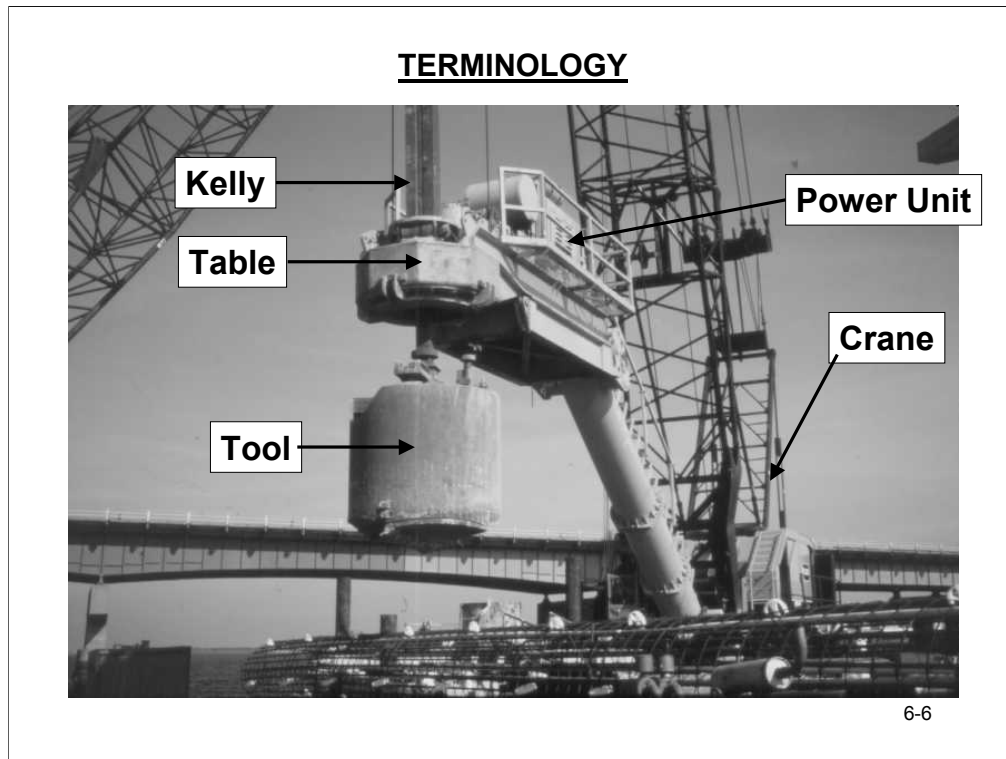
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LEARNING OBJECTIVES

- **Identify auger rig components**
- **Locate and employ information on auger rigs**
- **Identify drilling tools and explain their uses**

6-5



Crane- This is the carrier or main component- Most common rotary- Can be truck, track, crane or crawler mounted.

Power Unit- This unit provides the power that turns the table and kelly.

Kelly- This is the rod that runs through the table and the tools are attached to. Can be one-piece or telescoping.

Table- This is connected to the power unit and is what turns the kelly.

Tool- These are the bits, auger, buckets, etc. that go down the hole.

TERMINOLOGY

Buckets- generally two types;

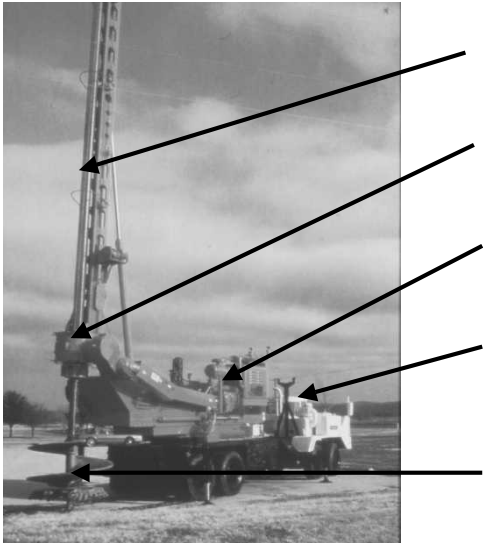
Digging- for excavating soils or soft rock

Cleanout- for cleaning of the shaft

Bits- typically are for excavating (drilling) and can be either auger or barrel type. Certain types used for soil and certain types for rock.

6-7

LEARNING OBJECTIVE # 1
Identify auger rig components



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RIGS**Predominately**

- **American Manufacturer Types**
- **European Manufacturer Types**

6-9

The variety of auger rigs available to contractors is considerable, particularly when you include both U.S. and European technology. Catalogs from the early 1900's show that bucket type auger drills were available even then, if you owned a horse to power it. Mechanical units were developed in the 1920's with production models in the late 1930's. This early history appears to have had its roots in Texas.

Reportedly the famous Hughes LL Series of diggers were being manufactured at the rate of 70 to 80 units per year in the late 1970's and early 1980's. Beginning in the early 1980's, it was clear that most equipment manufacturers in the U.S. were moving away from mechanical designs, opting instead for torque converters to deliver power to the rotary table/kelly bar drills.

Importing of European designed drills began roughly a decade ago and is gaining popularity among some contractors. Out of Germany are units built by Delmag and Bauer. SoilMec is one of the leading Italian manufacturers as are Casagrande and IMT. All of these companies now have manufacturers' representatives in the United States.

Perhaps one of the most attractive features of the European designs is the ability of the drill equipment to install casing. Many of these units are capable of drilling holes 120" (3 m) in diameter, to a maximum depths of 120 feet (40 m). Where casing is required, the drill utilizes a high torque, top-head drive along with down pressure to advance sections of casing which can be easily bolted to the casing adaptor (drive head). An auger or drilling bucket can remain attached to the kelly and used to remove material as required to facilitate advancement of the casing.

TYPES OF RIGS

- **Truck-Mounted Rigs**
- **Carrier-Mounted Rigs**
- **Crane-Mounted Rigs**
- **Crawler-Mounted Rigs**

6-10

Crane attachments in conjunction with large vibratory hammers appear to be the most popular equipment combination for contractors on big projects today. However, contractors tend to own equipment that works best for the type of work they do most often. There also appears to be a certain “mind-set” among some who favor a particular line of equipment and simply won’t consider any other kind.

What this means to us as Inspectors is that we are apt to see a wide variety of drill units on DOT work. In this lesson, the basic types of both American and European equipment are discussed so that the majority of the name brands will be familiar and you can better identify the relative sizes and capabilities of the various drill units.



TYPES OF RIGS- **LIGHT TRUCK-MOUNTED**

Calweld

6-11

The design diameter and depth of the shafts for a particular job will largely dictate what types of equipment will be the most economical to use. For instance, most high mast lighting foundations can be excavated with truck-mounted equipment similar to that illustrated above.

TYPES OF RIGS- LIGHT TRUCK-MOUNTED



**H & T 635
48" Dia.; 35 ft.**

6-12



TYPES OF RIGS-
CARRIER-MOUNTED

Texoma Taurus XL
120 in. Dia; 120 ft.

6-13

For large hole diameters and greater depths, equipment weights dictate that crane carriers be used if rubber-tired transport is desired.



TYPES OF RIGS-
CARRIER-MOUNTED

IMT AF16-A
80 in. Dia; 200 ft.

6-14

TYPES OF RIGS- CRAWLER-MOUNTED



**Soilmec R622
100 in. Dia; 245 ft.**

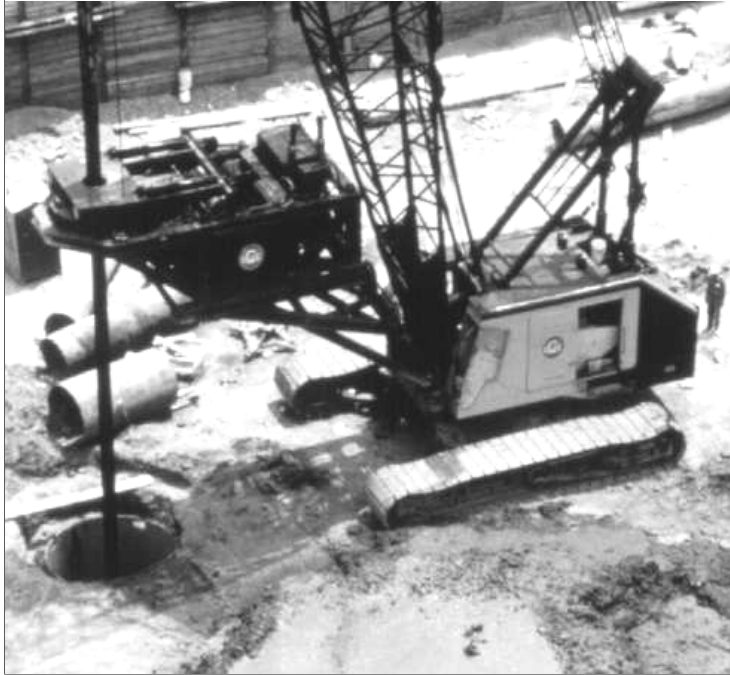
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TYPES OF RIGS-
CRAWLER-MOUNTED

Bauer
120 in. Dia; 195 ft.

6-16

TYPES OF RIGS- CRANE-MOUNTED

140 in. Dia.;
285 ft.

6-17

If there is a need for a larger drill, with greater torque and depth capability, contractors frequently use, what is termed in the industry as “crane attachment” drills. The power of some of these rigs can be truly impressive. Crane attachments come as a unit, including a diesel engine, transmission and torque converter driving a heavy duty rotary table through which a kelly is installed. The entire drill unit is attached to a crane using a “bridge” which allows the rotary table to be rigidly held and sufficiently elevated to accommodate the drilling tools anticipated for the job. Given the power advantages offered by large crane attachments, it is the ability to vary the working room (clearance) under the rotary table which makes this type of drill so attractive for many jobs.

The depth capability of crane attachment drills is dependent on the crane used.

TYPES OF RIGS- CRANE-MOUNTED



Hain 754

**Diameter and Depth
dependent upon
configuration.**

6-18

RIG INFORMATION

**Contact the Manufacturers for
the latest information on the
various models and capabilities**

**See Following detailed information sheets
for contact information and rig capabilities**

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DRILLED SHAFT AUGER RIGS

AMERICAN MANUFACTURERS



ATLANTIC EQUIPMENT COMPANY

Post Office Box 1
3710 Lee Highway
Gainesville, VA 22065
Tel: (800) 822-8248
(703) 754-7114
Fax: (703) 754-7437

MODEL	MAX. SHAFT DIA.		MAX. SHAFT DEPTH		MAX. TORQUE	
Drill Master TMCD60T	75"	1900 mm	57'	18 m	33,333 ft-lbs	45 kNm
Drill Master DM80T	95"	2400 mm	100'	30 m	51,622 ft-lbs	70 kNm
Williams LDH	88"	2235 mm	100'	30 m	49,410 ft-lbs	67 kNm
Williams LLDH	120"	3048 mm	115'	36 m	99,557 ft-lbs	135 kNm

AMERICAN EQUIPMENT & FABRICATING CORP.



100 Water Street
3710 Lee Highway
East Providence, RI 02914
Tel: (401) 438-2626
Fax: (401) 438-0764
www.american-equipment.com

DRILL RIGS	CASING DRIVERS	LOAD TEST EQUIPMENT
Soilmec Models	H.M. Vibro PTC	Osterberg Load Cell

DRILLED SHAFT AUGER RIGS

AMERICAN MANUFACTURERS



CALWELD

190 Industrial Boulevard
Post Office Box 534
McKinney, TX 75070-0534
Tel: (214) 548-9211
Fax: (214) 548-9956

MODEL	MAX. SHAFT DIA.		MAX. SHAFT DEPTH		MAX. TORQUE	
ADL	72"	1828 mm	100'	30 m	64,896 ft-lbs	88 kNm
ADM	60"	1524 mm	57'	18 m	64,896 ft-lbs	88 kNm
125 CH (Crane)	186"	4730 mm	*	*	124,631 ft-lbs	169 kNm
155 CH (Crane)	186"	4730 mm	*	*	152,654 ft-lbs	207 kNm
400 CH (Crane)	204"	5180 mm	*	*	399,705 ft-lbs	542 kNm

* Dependent upon crane size and capability



STEVEN M. HAIN CO.

Post Office Box 1
3710 Lee Highway
Gainesville, VA 22065
Tel: (800) 822-8248
(703) 754-7114
Fax: (703) 754-7437

MODEL	MAX. SHAFT DIA.	MAX. SHAFT DEPTH	MAX. TORQUE	
4-71//3531-3 (Crane)	*	*	167,404 ft-lbs	227 kNm
8V71/754 (Crane)	*	*	374,631 ft-lbs	508 kNm
3-53T/3331-1 (Crane)	*	*	102,507 ft-lbs	139 kNm

* Dependent upon crane size and capability

DRILLED SHAFT AUGER RIGS

AMERICAN MANUFACTURERS



REEDRILL/TEXOMA

190 Industrial Boulevard
Post Office Box 534
McKinney, TX 75070-0534
Tel: (214) 548-9211
Fax: (214) 548-9956

MODEL	MAX. SHAFT DIA.		MAX. SHAFT DEPTH		MAX. TORQUE	
Texoma 600	72"	1,828 mm	30'	10 m	40,560 ft-lbs	55 kNm
Texoma 700	72"	1,828 mm	57'	18 m	53,834 ft-lbs	75 kNm
Texoma 800	85"	2,438 mm	85'	207 m	57,522 ft-lbs.	78 kNm
Texoma 900	85"	2,438 mm	115'	36 m	104,719 ft-lbs.	142 kNm
Texoma Taurus XL	120"	3,048 mm	115'	36 m	143,805 ft-lbs.	195 kNm
Texoma C-100	85"	2,438 mm	115'	36 m	99,557 ft-lbs.	135 kNm



WATSON

Post Office Box 1
3710 Lee Highway
Gainesville, VA 22065
Tel: (800) 822-8248
(703) 754-7114
Fax: (703) 754-7437

MODEL	MAX. SHAFT DIA.		MAX. SHAFT DEPTH		MAX. TORQUE	
1500	76"	1,930 mm	86'	27 m	56,047 ft-lbs.	76 kNm
2500	86"	2,440 mm	86'	27 m	80,383 ft-lbs.	109 kNm
3100	86"	2,440 mm	115'	36 m	99,557 ft-lbs.	135 kNm
500CA (Crane)	120"	3,050 mm	138'	43 m	98,820 ft-lbs	134 kNm
EDT-7 (Crane)	54"	1,370 mm	87'	18 m	53,834 ft-lbs	73 kNm

DRILLED SHAFT AUGER RIGS

EUROPEAN MANUFACTURERS



BAUER

Post Office Box 1
3710 Lee Highway
Gainesville, VA 22065
Tel: (800) 822-8248
(703) 754-7114
Fax: (703) 754-7437

MODEL	MAX. SHAFT DIA.		MAX. SHAFT DEPTH		MAX. TORQUE	
BG9	52"	1300 mm	130'	40 m	68,584 ft-lbs	90 kNm
BG14	72"	1800 mm	180'	55 m	103,244 ft-lbs	140 kNm
BG18	72"	1800 mm	130'	40 m	162,241 ft-lbs	220 kNm
BG30	120"	3000 mm	195'	60 m	265,486 ft-lbs	360 kNm
BG50	100"	2500 mm	260'	80 m	265,486 ft-lbs	360 kNm



CASAGRANDE

190 Industrial Boulevard
Post Office Box 534
McKinney, TX 75070-0534
Tel: (214) 548-9211
Fax: (214) 548-9956

MODEL	MAX. SHAFT DIA.		MAX. SHAFT DEPTH		MAX. TORQUE	
B130E	65"	1,600 mm	155'	48 m	93,657 ft-lbs	127 kNm
B220	100"	2,500 mm	218'	68 m	152,654 ft-lbs	207 kNm
C600	100"	2,500 mm	265'	81 m	401,917 ft-lbs	545 kNm
C800	100"	2,500 mm	265'	81 m	294,985 ft-lbs	400 kNm

DRILLED SHAFT AUGER RIGS

EUROPEAN MANUFACTURERS



IMT

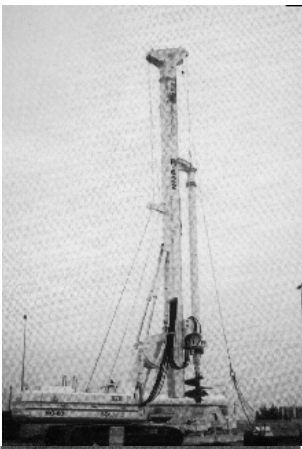
Post Office Box 1
3710 Lee Highway
Gainesville, VA 22065

Tel: (800) 822-8248

(703) 754-7114

Fax: (703) 754-7127

MODEL	MAX. SHAFT DIA.		MAX. SHAFT DEPTH		MAX. TORQUE	
AF6	48"	1,200 mm	105'	32 m	46,460 ft-lbs	63 kNm
AF10	60"	1,500 mm	135'	42 m	75,221 ft-lbs	102 kNm
AF12	60"	1,800 mm	195'	60 m	84,808 ft-lbs	115 kNm
AF15	72"	1,800 mm	193'	60 m	115,044 ft-lbs	156 kNm
AF18	72"	1,800 mm	190'	59 m	136,430 ft-lbs	185 kNm
AF20	80"	2,000 mm	200'	62 m	147,492 ft-lbs	200 kNm
AF50	120"	3,000 mm	285'	89 m	368,731 ft-lbs	500 kNm



SOILMEC

190 Industrial Boulevard
Post Office Box 534
McKinney, TX 75070-0534

Tel: (214) 548-9211

Fax: (214) 548-9956

MODEL	MAX. SHAFT DIA.		MAX. SHAFT DEPTH		MAX. TORQUE	
R-208	48"	1,200 mm	130'	40 m	77,651 ft-lbs	82 kNm
R-312	60"	1,500 mm	130'	40 m	83,333 ft-lbs	113 kNm
R-412	60"	1,500 mm	150'	46 m	80,383 ft-lbs	109 kNm
R-515	60"	1,500 mm	200'	62 m	105,457 ft-lbs	143 kNm
R-618	80"	2,000 mm	193'	60 m	126,843 ft-lbs	172 kNm
R-622	100"	2,500 mm	245'	76 m	148,230 ft-lbs	201 kNm
RT3-ST (Crane)	100"	2,500 mm	260'	80 m	151,916 ft-lbs	206 kNm

LEARNING OBJECTIVE # 2

Locate and employ information on auger rigs

The Contractor is to install drilled shafts 96” in diameter to a depth of 110 feet. Using the Rig Manufacturer information sheets, identify the rigs capable of doing the job by manufacturer and model. No crane rigs please.

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AUGER BITS AND TOOLS

6-26

It has often been said that an auger drill, no matter how large or powerful, is no better than the tool at the end of the kelly. If you have ever tried to use a small hand drill with a worn bit, you can relate to how it can affect production.

For that reason, tools have been fabricated for virtually every below ground condition imaginable. The most common augers can be classified as either dirt (soil) or rock types, with variations of each as to the number of flights, teeth, and lead bit. Many contractors build their own designs, but there are a number of manufacturers who specialize in drilling tools as well.

AUGER BITS & TOOLS

Earth Auger Bits

- Single or double flight
- Double flight has superior soil removal capability

Auger bits are generally classified as either:

- **Earth (Soil)** or
- **Rock**

Rock Auger Bits

- Double or Triple flight
- Single Core Barrels
- “Air Barrels” (Double Wall Core Barrel)

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WHY IS THIS IMPORTANT

The Inspector must be able to:

- **Compare to the approved Drilled Shaft Installation Plan**
- **Note on daily activity report the equipment on-site**
- **Recognize and document the tool being used**
- **Recognize and document the condition of the tools**

6-28

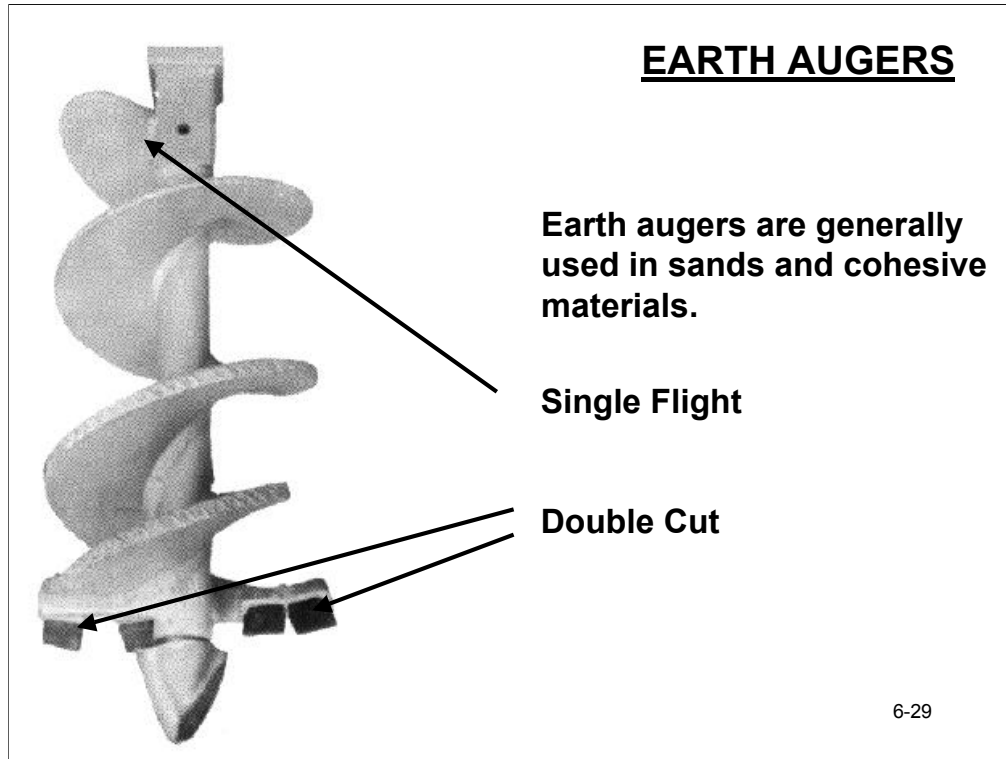
The Inspector must have the knowledge to identify the various drilling tools being used by the Contractor.

Remember- it is not the Inspector's responsibility to direct the Contractor's work or technique.

However, the Inspector must make accurate notes as to the tools and equipment on-site and being used.

If the Contractor only has earth augers on site and rock needs to be penetrated, it is important to have this information notes, as the Contractor may say the material cannot be penetrated and was misrepresented or harder than indicated. May not really be so if they had the right bit.

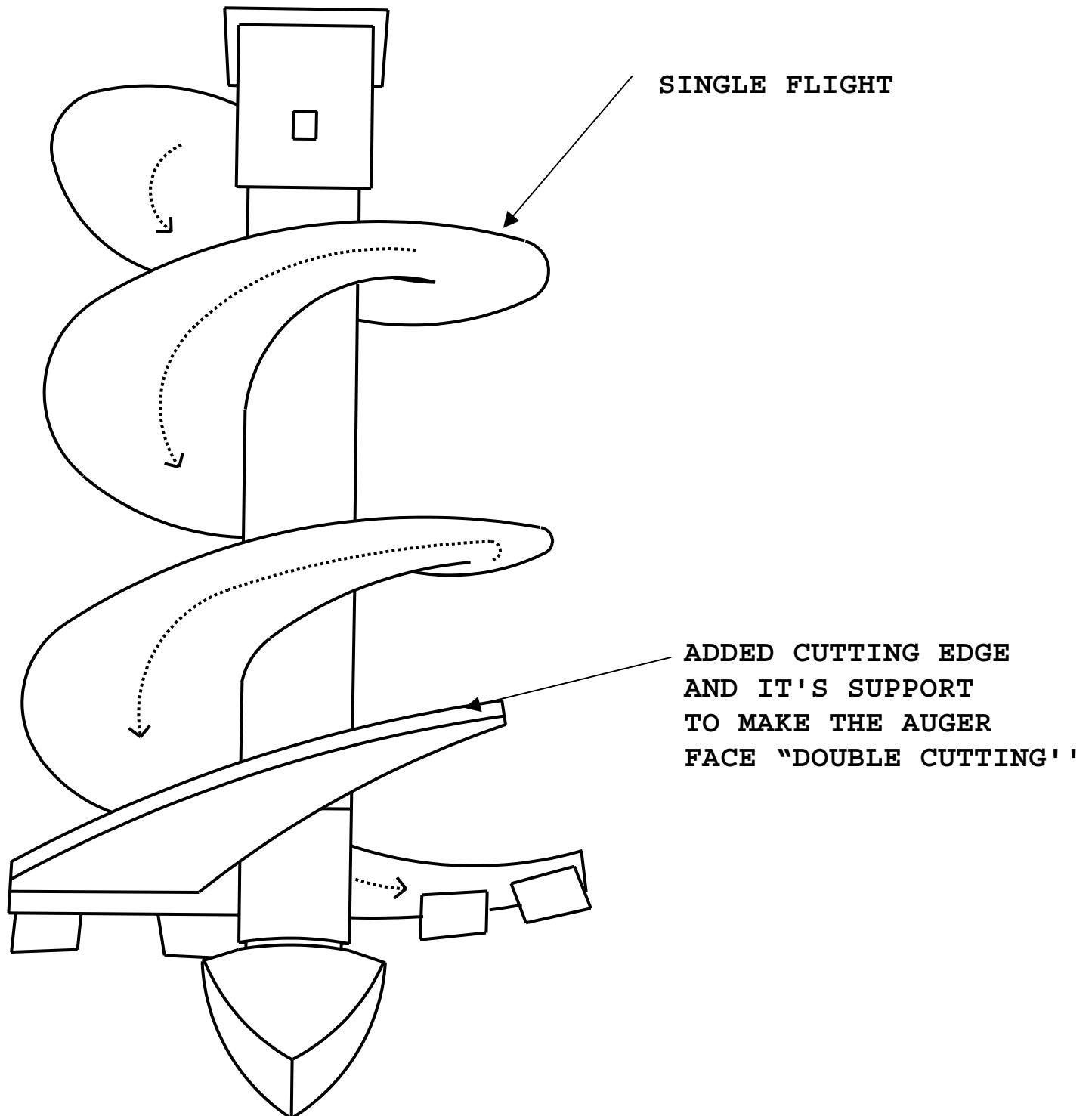
The Inspector's accurate, unbiased observations and documentation can help alleviate problems or questions that might arise.

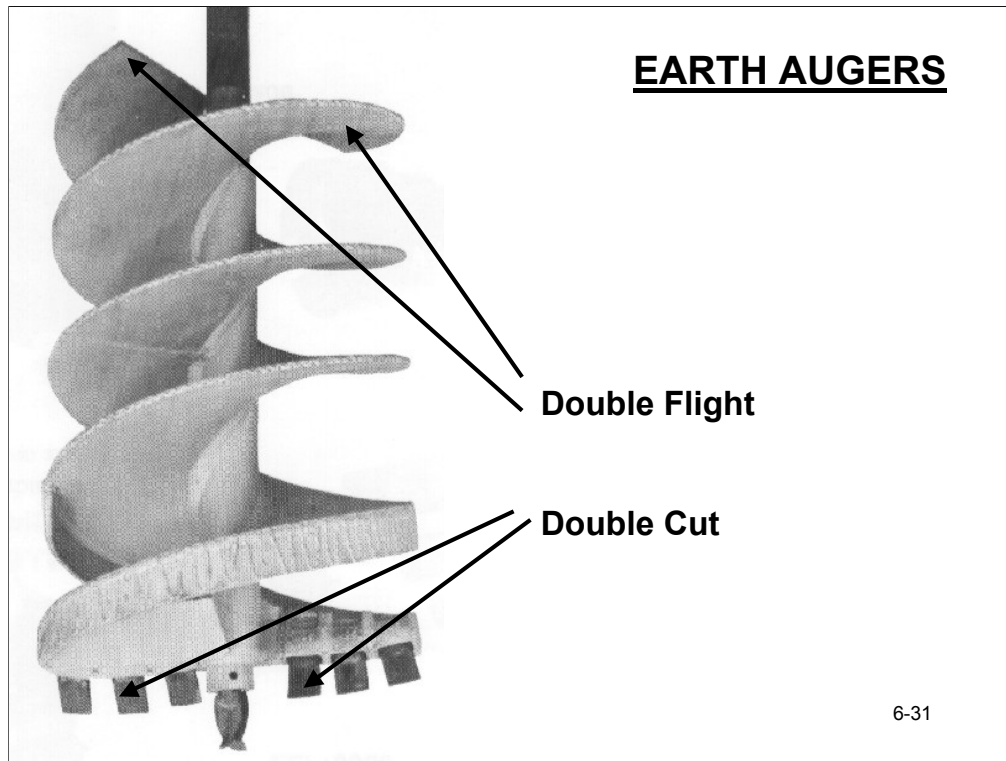


Dirt augers are usually made with single or double flights. Above is a single flight auger designed so as to cut on both sides of the stem. These are distinguished from rock augers by the use of lighter weight material and flat edge blades as cutting teeth. Because of their superior removal capacity, double flight designs are usually best for the fine sandy soils.

Full size drawing follows.

SINGLE FLIGHT - DOUBLE CUT EARTH AUGER

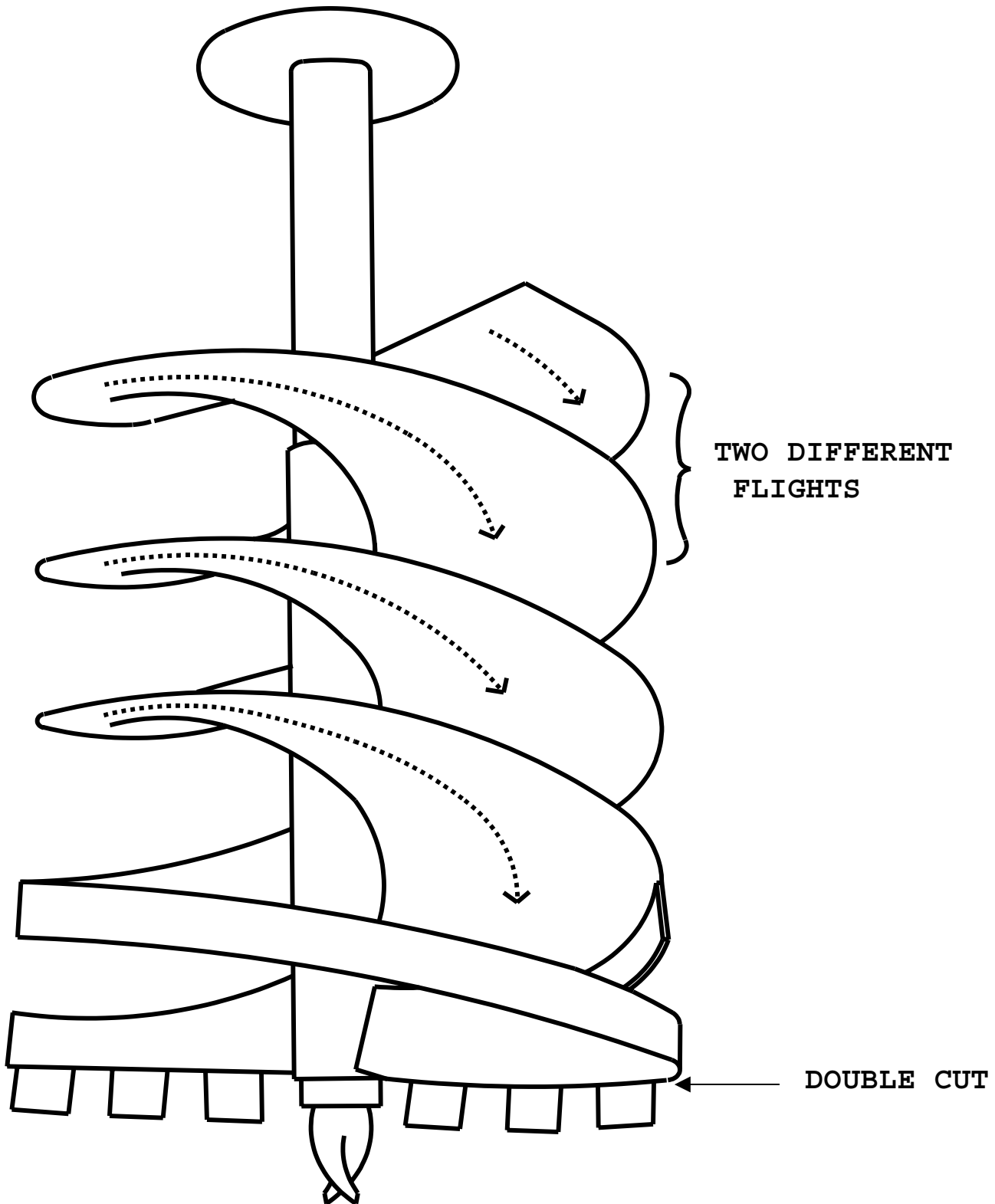


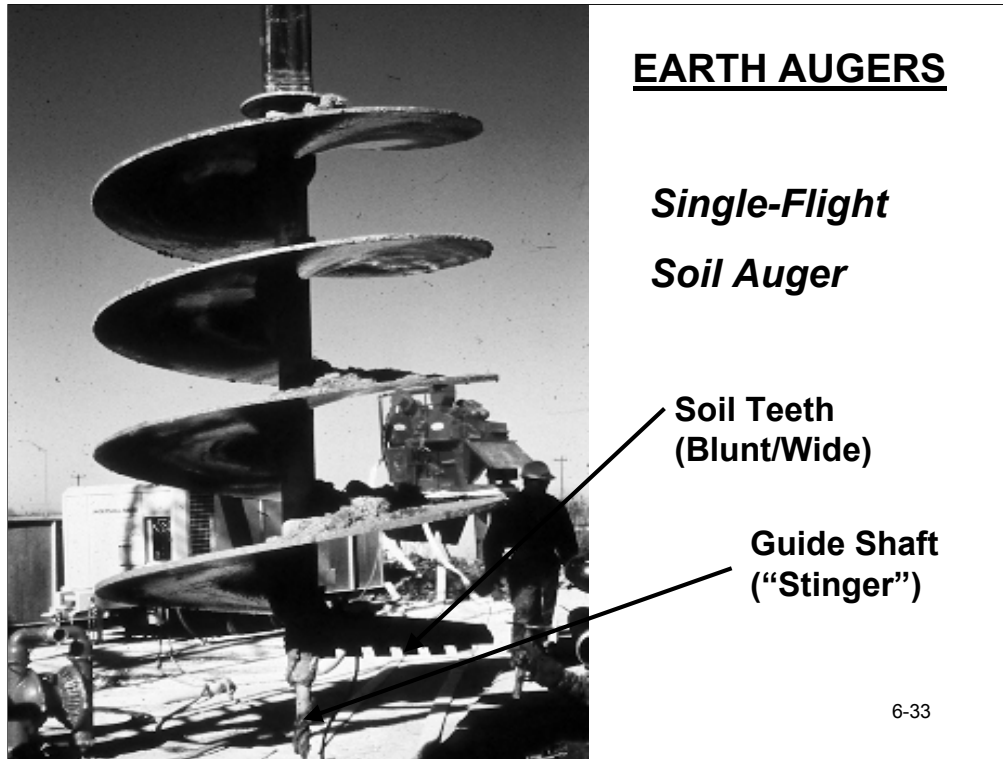


Full size drawing follows.

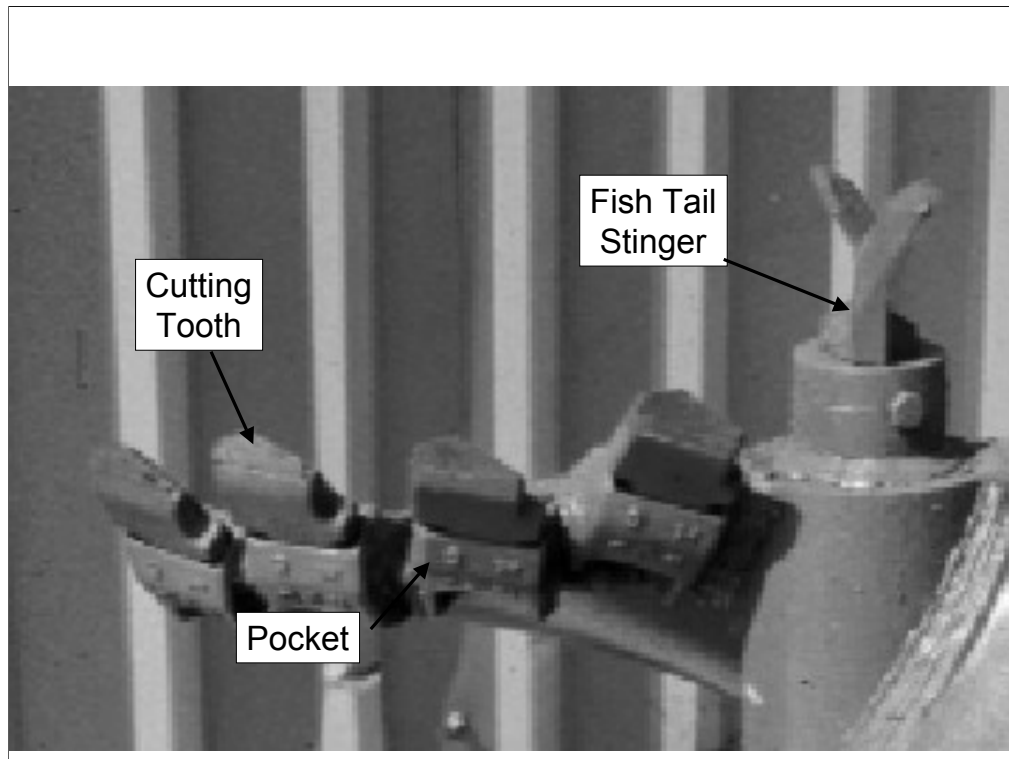
Double cut augers make it easier to keep the hole straight since they are less likely to “walk” to one side.

DOUBLE FLIGHT - DOUBLE CUT EARTH AUGER





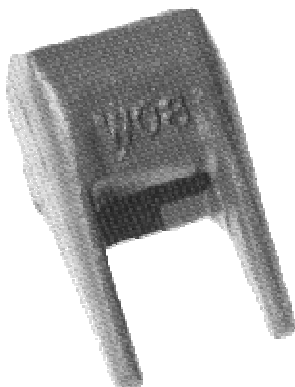
This is a standard single-helix (flight) auger for excavating relatively weak soils that have some cohesion. Sometimes, it can be used to excavate IGM's or soft rock if the IGM or rock is horizontally bedded and bedding planes are very closely spaced. Note the tooth design for gouging out large volumes of soil and the several turns on the auger, which allows for transport of considerable soil to the surface at one pass.



These are typical of the cutting teeth used on earth augers. The Pocket, which holds the cutting teeth, is welded onto the auger. This allows for changing out broken or worn teeth. The stinger bit aids in keeping the axial alignment and minimizing “walking off”.

Stinger Bits

Pocket



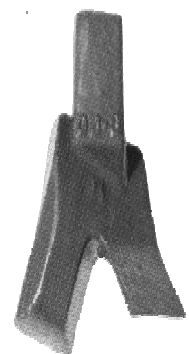
Cutting Tooth

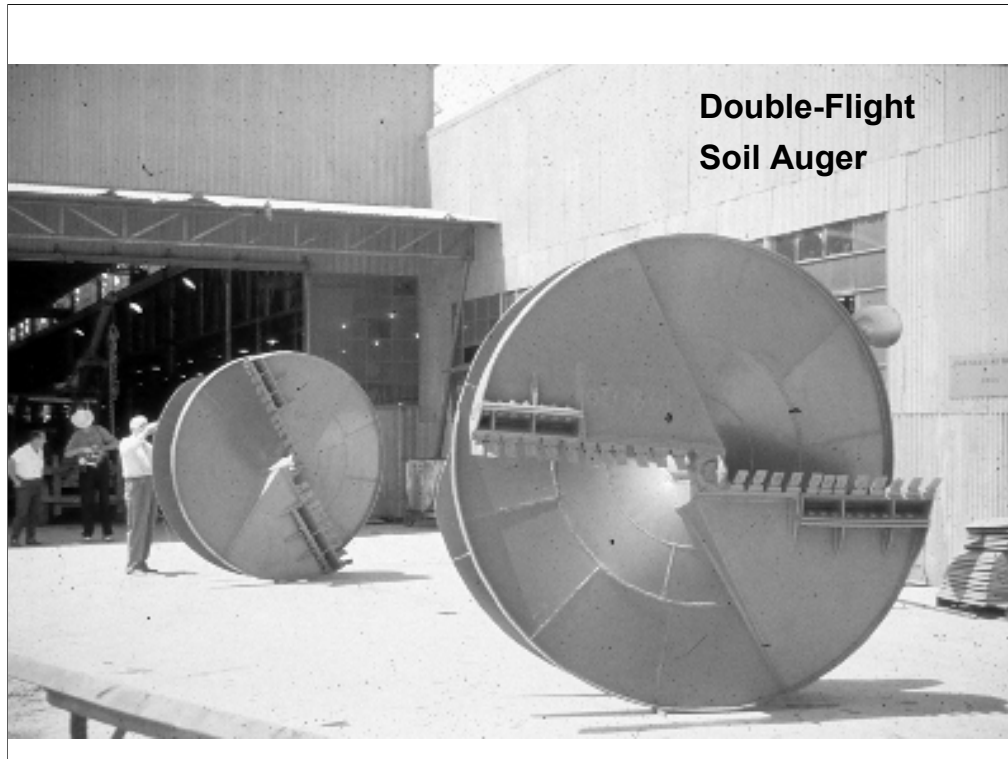


Spade

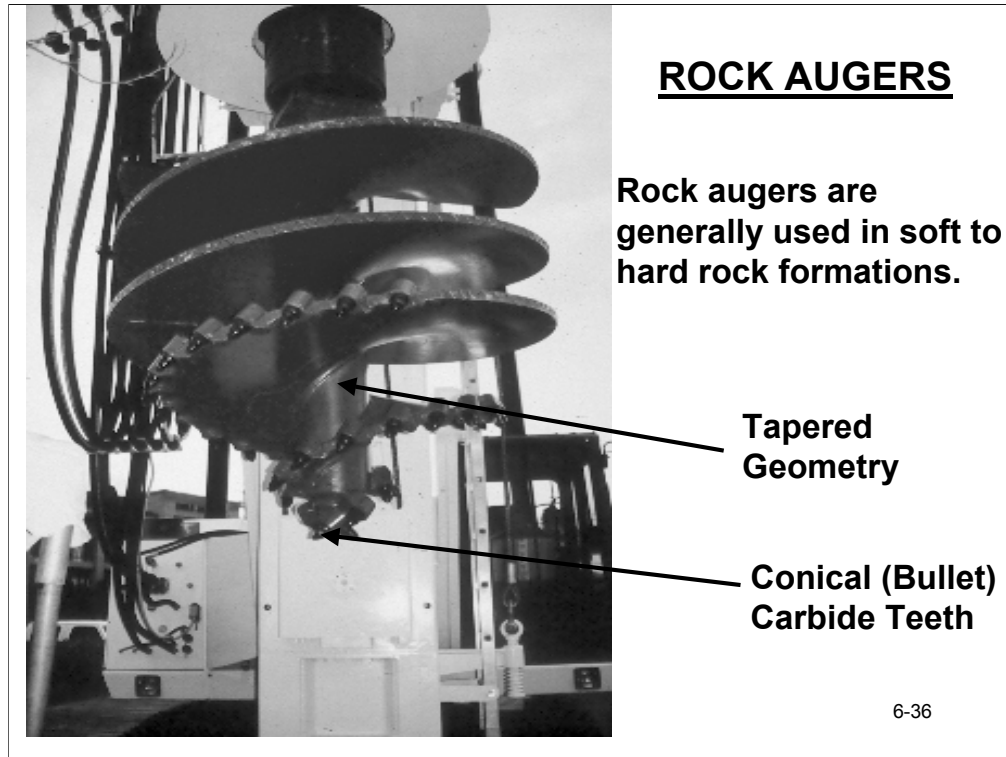


Fish Tail



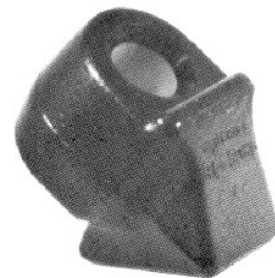
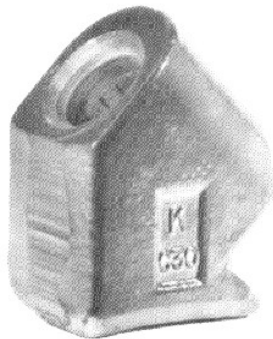


The Contractor may have trouble maintaining hole alignment or jamming the auger in the hole if the hole diameter becomes larger than 5 to 8 feet (1.5 to 2.5 m), depending upon the hardness and regularity of the soil. In such a case, he or she should change to a double helix auger such as this. Note that the opposing rows of teeth will give a balanced torque reaction on the cutting face. The auger has only a little more than one turn to reduce torque reaction from the sidewalls.

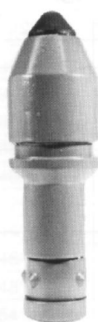


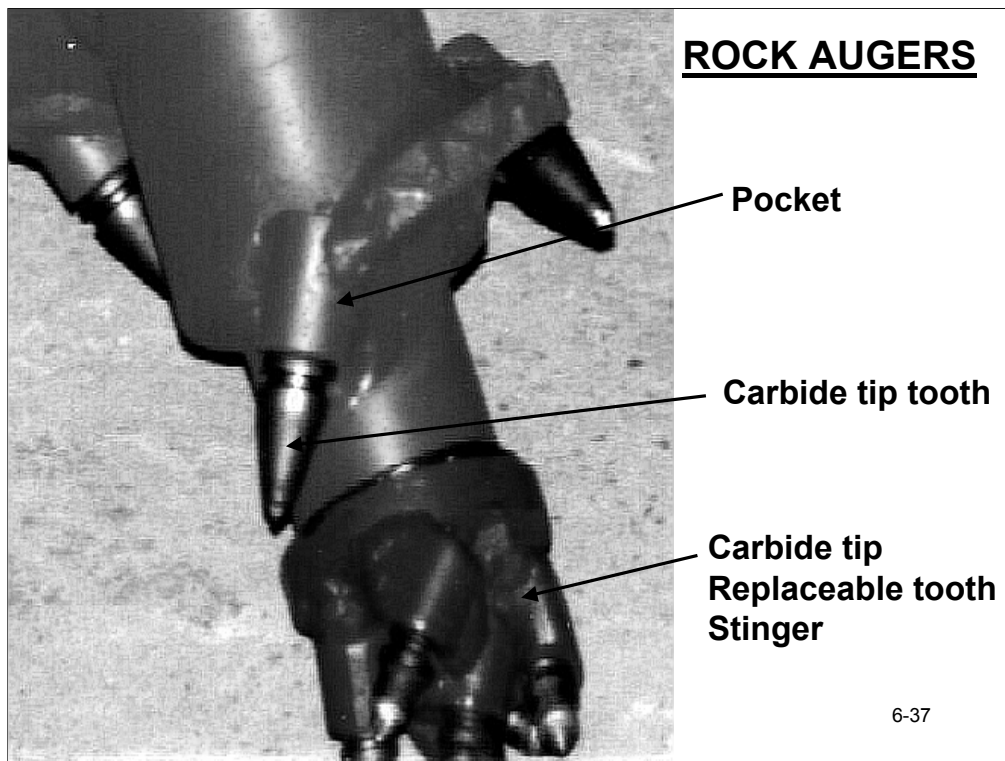
When soil augers and buckets fail to excavate the geomaterial, contractors frequently use rock augers. A typical rock auger is shown here. The rock is broken into small pieces by the ripping (tungsten carbide) teeth and either lifted out on the auger or removed with a claim or other tool. Some rock is so hard, however, that rock augers will not be effective.

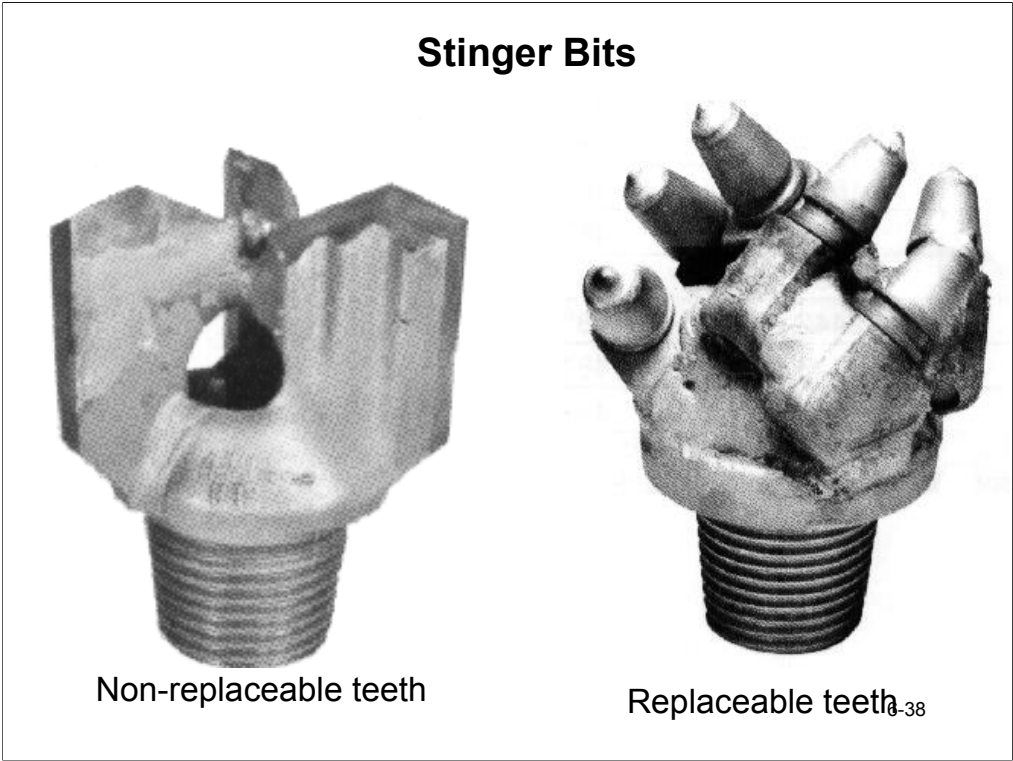
Pockets



Carbide Bit Teeth



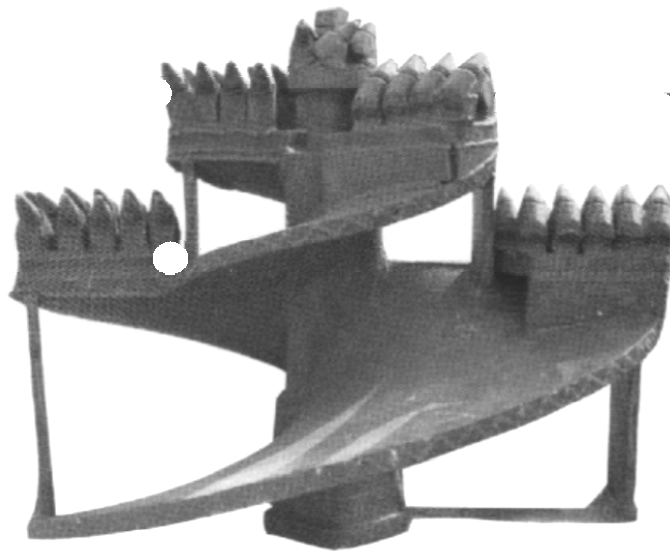




ROCK AUGERS

**This is typical rock
auger designed for
drilling in soft to
medium rock.**

6-39



Rock auger for soft rock.

ROCK AUGERS

These are typical of rock augers designed for drilling in hard rock.

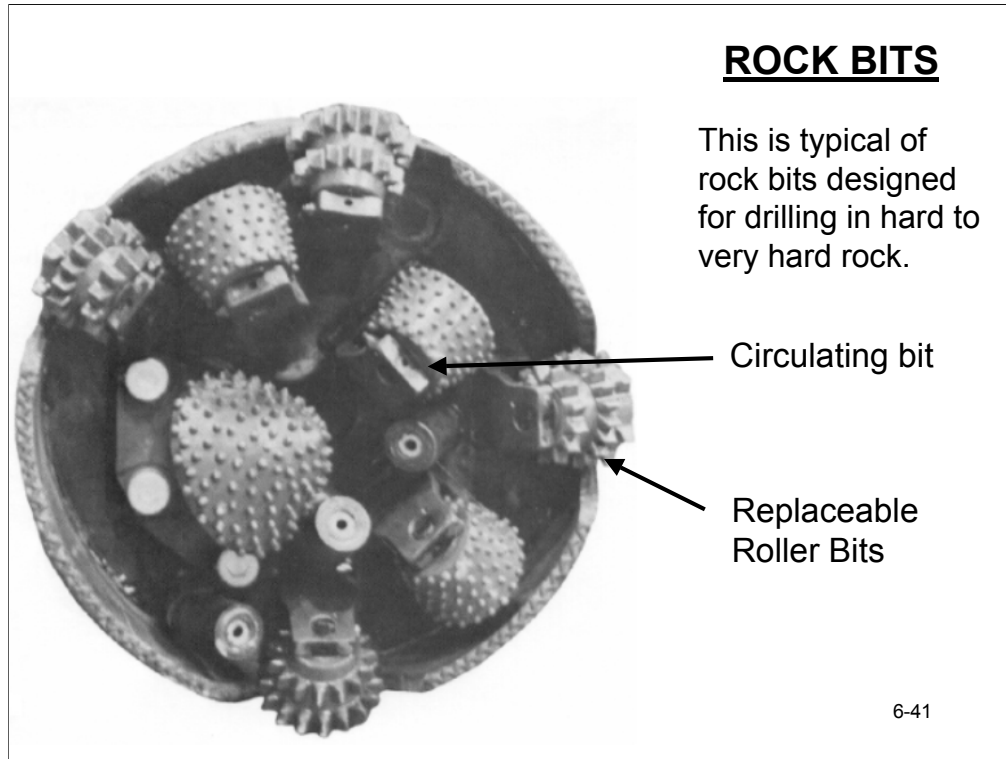


BULLET STEP TYPE
3 Way Rock Auger

6-40



R-5000
Step Type Rock Auger



When rock augers are not sufficient to excavate rock because it is too hard, these (and other) tools might be considered.

Above is a cluster drill. This tool beats (pulverizes) the rock, and using a process known as "reverse circulation," sucks the slurry-cuttings suspension off the bottom of the borehole. These devices will work in massive rock even when core barrels will not.



This is a step-faced roller bit, which grinds rock first in a small pilot hole (near the center), which weakens the remaining rock in the borehole, followed by the remainder of the hole (near the outer circumference). Cuttings are forced to the surface with compressed air with this tool.

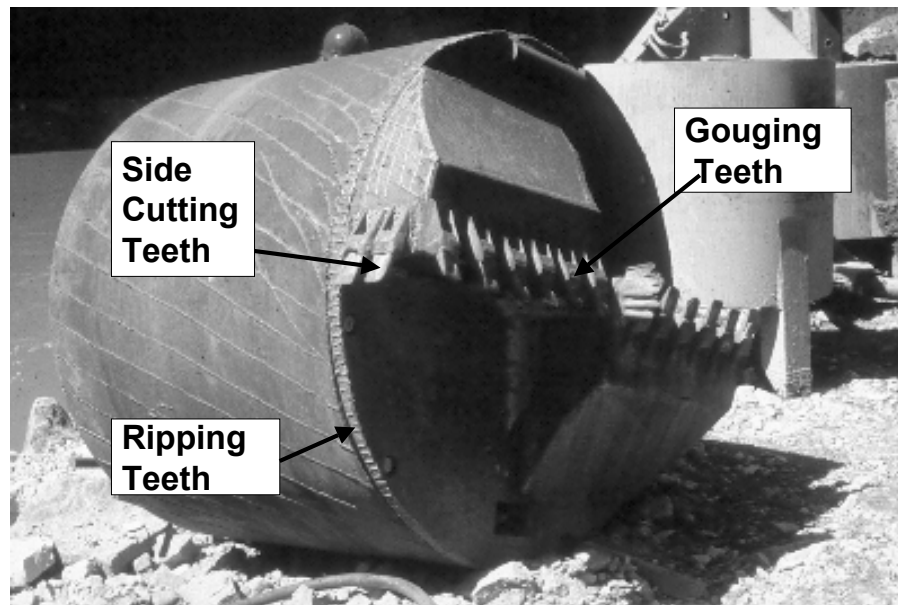
Other Options in Hard Rock



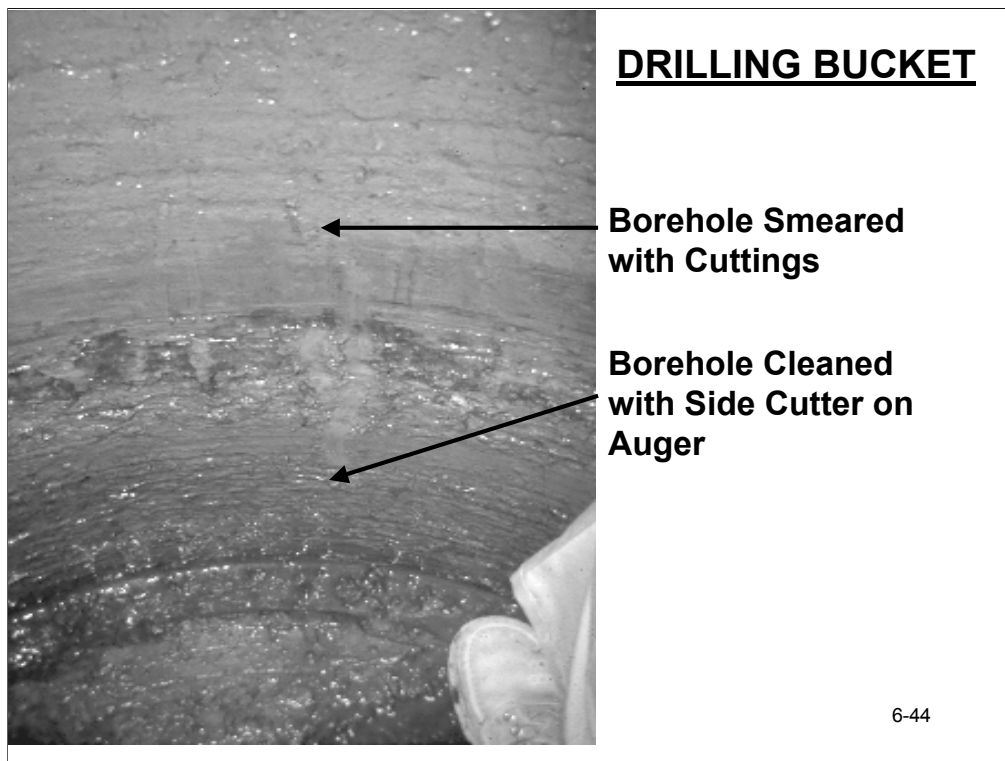
Does not use circulation to remove cuttings and is designed for small jobs with minimal footage. Uses replaceable roller bits.

DRILLING BUCKET

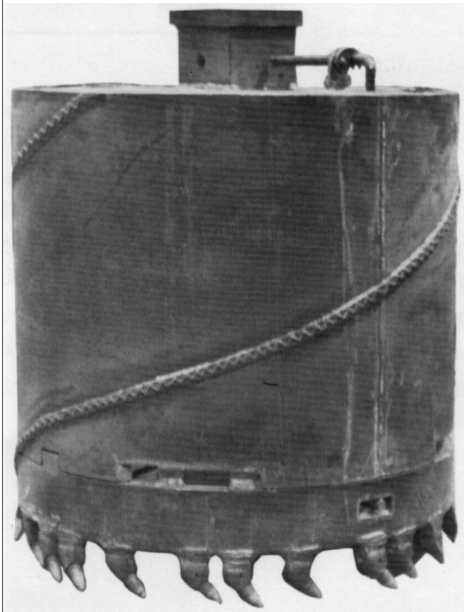
This is typical of a drilling bucket used in cobbles, gravel and clay.



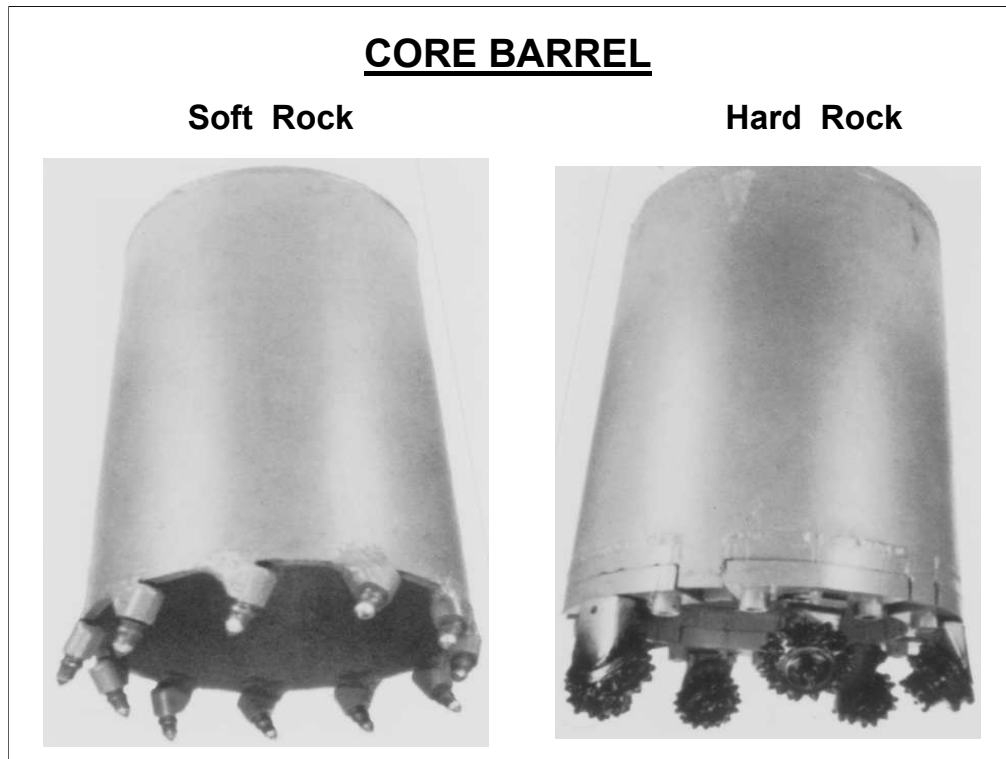
An auger will not work well in a truly cohesionless soil, like a sand or gravel, especially below the water table, where boreholes are often filled with drilling fluid. In such soil contractors often use drilling buckets, like this one. It is a good idea that these tools be vented to allow drilling fluids to bypass them during insertion and extraction of the tool when drilling under a fluid. This circumvents creating a piston effect during insertion or suction during extraction, which may cause the borehole to collapse. A flattened side or simple pipe passing through the tool can often be used for this purpose. Although it is the Contractor's responsibility to excavate the drilled shafts, when he or she cannot do so, it becomes the Engineer's problem. So, details such as this can be important.



BOULDER BUCKET & AUGER



Drilling Contractors and their suppliers have devised many ingenious tools. The one on the left, by the Stephen Hain Company, is a barrel (open-bottom bucket with tungsten carbide teeth around the perimeter of the bottom edge) that is used to maneuver boulders into the borehole and flaps that then grab the boulder to allow the driller to lift it to the surface for disposal. This tool can be used to augment drilling augers and buckets. Other devices, such as boulder rooters (tapered augers) can also be used for this purpose.

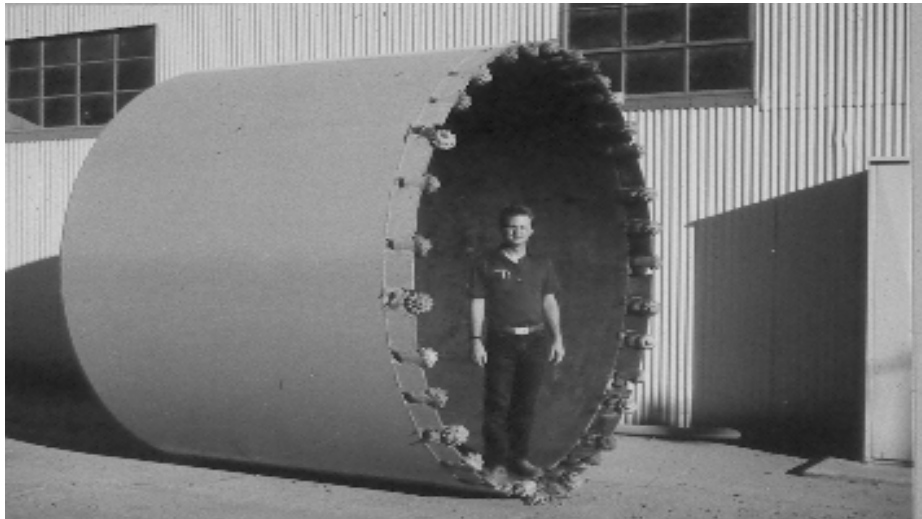


Harder, more dense rock formations may require the use of core barrels to speed advancement of the hole.

The concept of a core barrel is to minimize the amount of rock that has to be “cut” in order to deepen the hole, thereby accelerating the process. By using a single tube design, shown above left, the cutting force (down pressure and torque) can be concentrated along the perimeter of the barrel. This barrel uses replaceable carbide tipped “bullet” teeth.

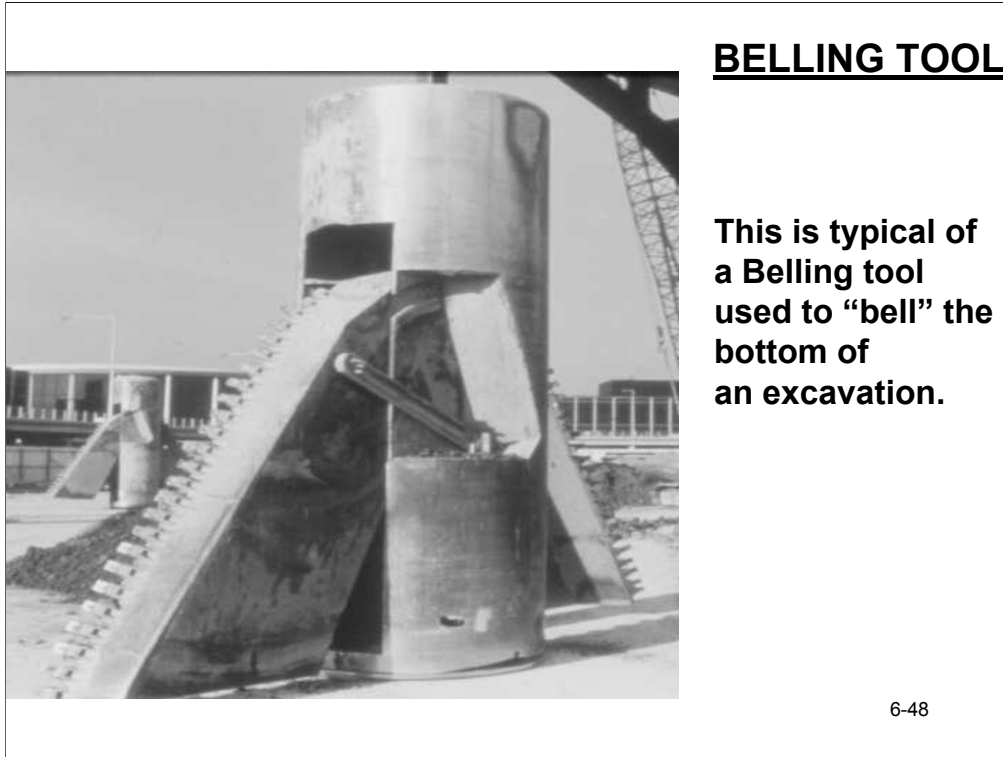
Larger drill units with sufficient down pressure and torque can utilize “air barrels” (on right above) effectively. This system uses large volumes of compressed air in conjunction with a double wall core barrel which can be equipped with a variety of cutting devices. These cutters can be replaced when worn, or exchanged for button-type bits for harder rock formations.

CORE BARREL



6-47

Above is a 10-foot-diameter, double-walled core barrel.



A belling tool can be used to make enlarged bases for drilled shafts in the dry or casing drilling processes.

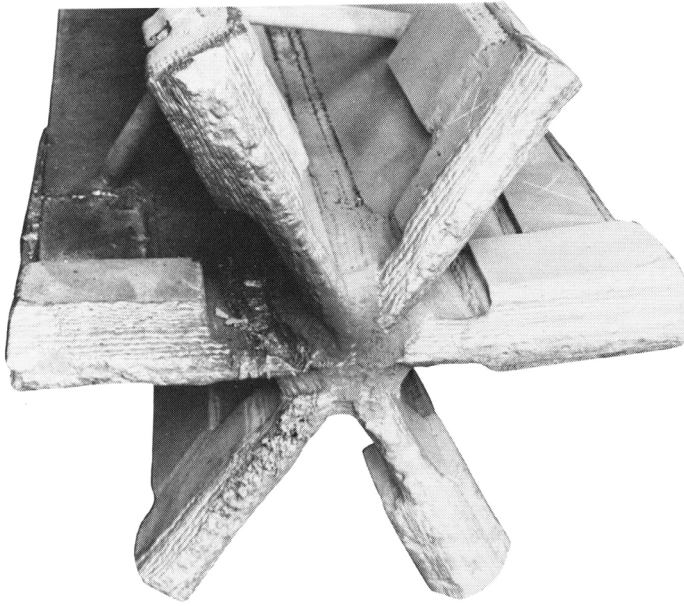


PERCUSSION DRILLING



Percussion drilling involves lifting and dropping a heavy tool on rock or boulders to break it up (such as the "chum drill" on the left) and then lifting out the debris (as with the borehole clam on the right). This method can be used in hard rock when core barrels will not work. More frequently it is used in boulder fields or zones of fragmented rock.

CHOPPING BIT



This bit is for breaking up rock that may not be augerable. Drop repeatedly from a crane.

6-50

CLEANOUT (MUCK) BUCKET

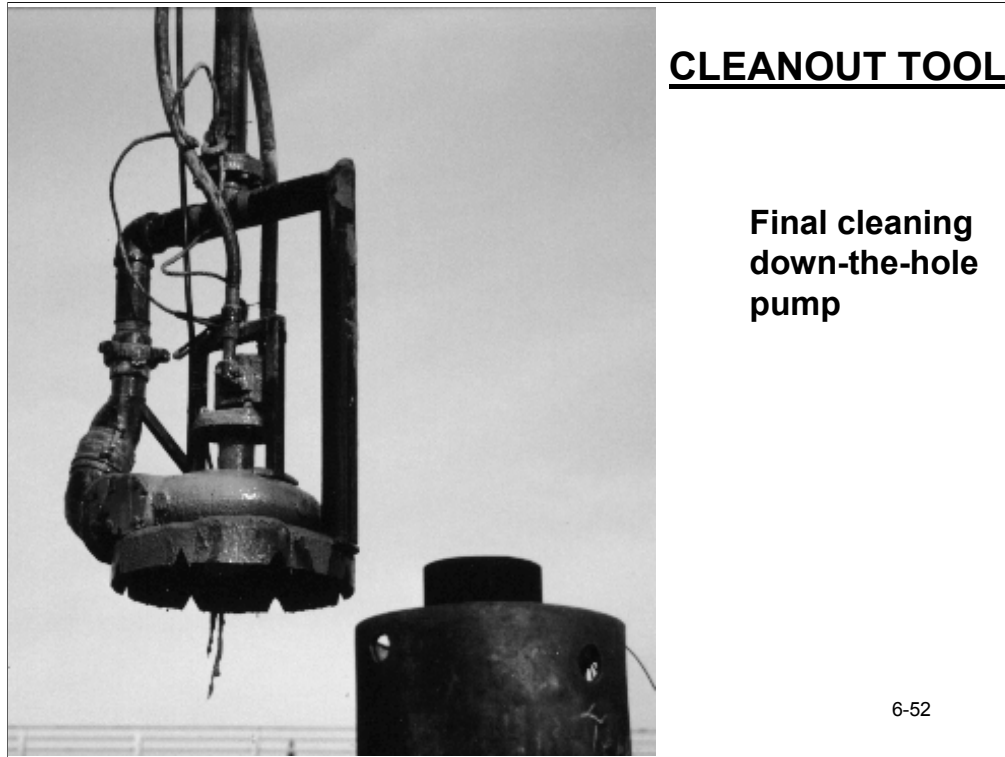


This is typical of a cleanout (muck) bucket used to cleanout the cuttings and sediments from the bottom of the shaft.

6-51

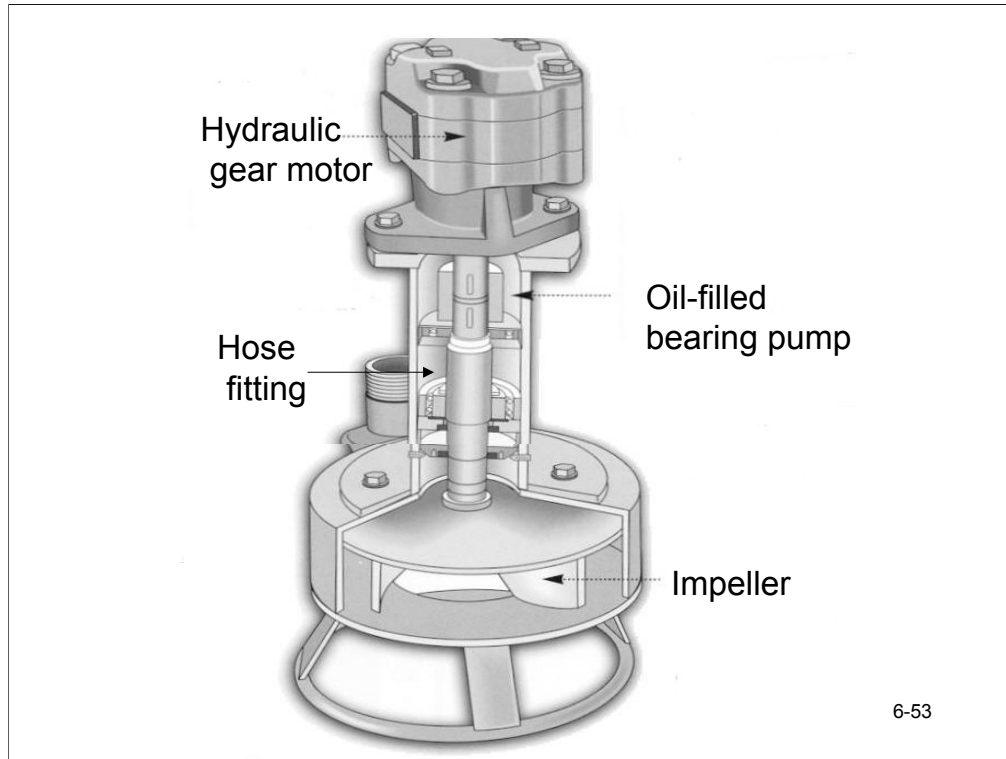
These rotating bottom muck buckets are used to remove the sediments and cuttings from the bottom of the shaft.

Normally cleanout buckets are at least 6 inches to 1 foot or more, smaller than the hole diameter, enabling movement around the hole bottom while reducing the danger of putting large negative pressures on the shaft excavation when the tool is withdrawn. Holes incorporated in this design assist in minimizing suction as well. This can be very important where rock formations contain significant amounts of sand.



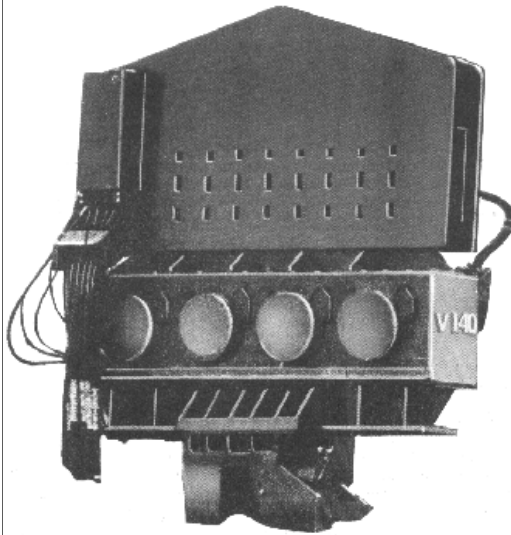
For final cleaning of the shaft, contractors frequently use down-the-hole pumps.

A hydraulically driven version of such a pump is shown here. Normally mineral slurry is pumped from the bottom of the shaft to a desanding unit while fresh slurry is replaced in the top of the shaft. Pumping shafts from the bottom greatly speeds the operation of shaft cleaning and gets better end results as opposed to extended periods of using muck buckets alone.



This is a schematic of a hydraulic submersible pump.

VIBRATORY HAMMER MANUFACTURERS



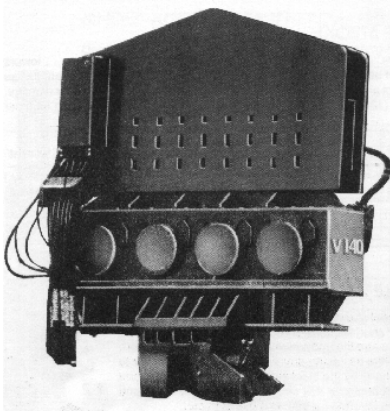
MKT



ICE 6-54

Vibratory hammers are used to install and remove casing.

VIBRATORY HAMMERS



MKT

Post Office Box 1
3710 Lee Highway
Gainesville, VA 22065
Tel: (800) 822-8248
(703) 754-7114
Fax: (703) 754-7437

MODEL	AMPLITUDE (mm)		ECCENTRIC MOMENT (kg-cm)		MAX. LINE PULL (kN)	
V-2A	0.75"	19 mm	0.75"	19 mm	15,962	71
V-5C	0.75"	19 mm	0.75"	19 mm	59,802	266
V-17	0.75"	19 mm	0.75"	19 mm	119,829	533
V20B	0.75"	19 mm	0.75"	19 mm	119,829	533
V-30	1.0"	25.4 mm	1.0"	25.4 mm	159,847	711
V-140	1.0"	25.4mm	1.0"	25.4mm	299,910	1,334



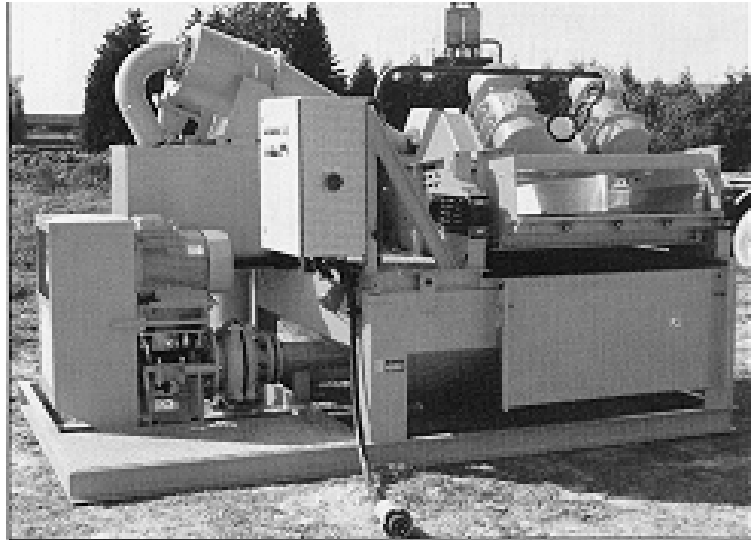
ICE

190 Industrial Boulevard
Post Office Box 534
McKinney, TX 75070-0534
Tel: (214) 548-9211
Fax: (214) 548-9956

MODEL	AMPLITUDE		ECCENTRIC MOMENT (kg-cm)		MAX. LINE PULL (kN)	
216	0.25-0.75"	6.35-19.0 mm	1,100 in-lbs	1,256	59,850 lbs	267 kN
416L	0.25"-0.75"	6.35-19.0 mm	2,200 in-lbs	2,534	80,035 lbs	356 kN
612	0.5"-1.0"	12.7-25.4 mm	4,400 in-lbs	5,069	80,035 lbs	356 kN
815	0.5"-1.0"	12.7-25.4 mm	4,400 in-lbs	5,069	100,044 lbs	445 kN
1412B	1.0"-1.5"	25.4-38.1 mm	10,000 in-lbs	11,520	300,134 lbs	1,335 kN

MISCELLANEOUS OTHER TOOLS

Desanders



Casing Twister

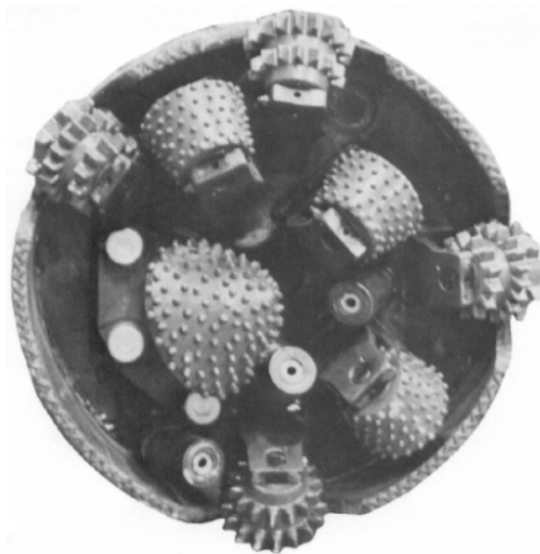




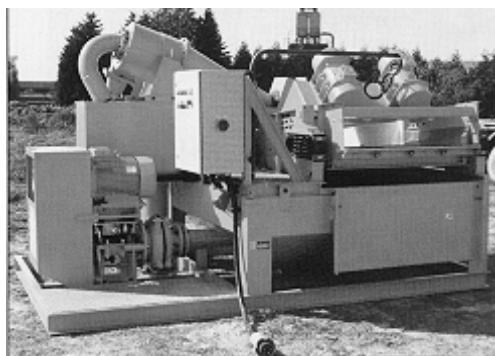
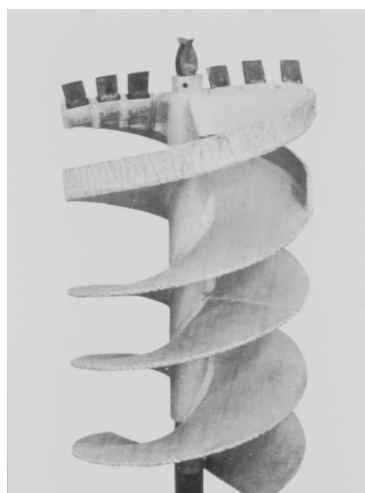
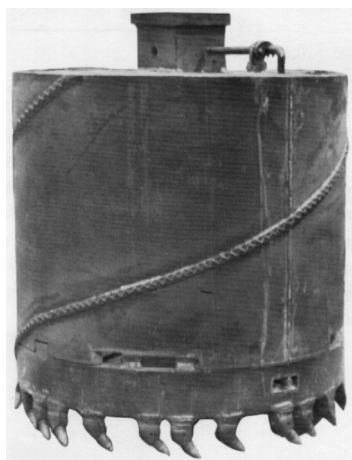
Overreaming
Bucket

6-58

LEARNING OBJECTIVE # 3
Identify drilling tools and explain their uses



6-59



LEARNING OBJECTIVES

- **Identify auger rig components**
- **Locate and employ information on auger rigs**
- **Identify drilling tools and explain their uses**

6-60

ANY QUESTIONS?



6-61

NOTES

[illegible]